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Aeration Blower Fundamentals

Thursday, November 19, 2020

1:00 – 3:00 PM ET

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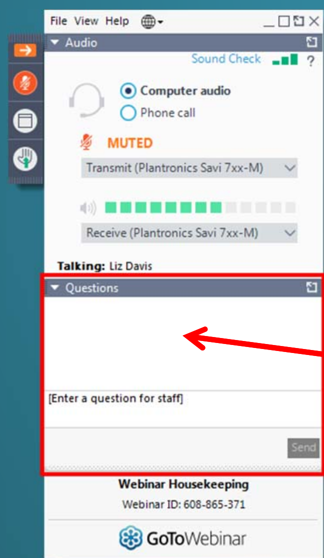
How to Participate Today



- **Audio Modes**
  - Listen using Mic & Speakers
  - Or, select "Use Telephone" and dial the conference (please remember long distance phone charges apply).
- **Submit your questions using the Questions pane.**
- **A recording will be available for replay shortly after this webcast.**

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Today's Moderator

Katie Zheng

Planning Manager

SouthWest Water Company
Texas Water Utility

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Today's Presentations

- Fundamentals of Operation and Maintenance
  - Thomas E. Jenkins, P.E.
- Total Control – Optimizing Your Process Correctly
  - Paul Petersen
- Aeration System Optimization – Lessons Learned from the Field
  - Hank Andres, P.Eng
- Selecting the Right Blower Type for the Application, Maximum Efficiency, and Ease of Maintenance
  - Julia V. Gass

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Tom Jenkins, PE

JenTech Inc.

- Independent consultant
- President JenTech Inc.
- Forty plus years experience with blowers and controls
- Adjunct Professor, University of Wisconsin, Madison
- Member of ASME PTC 13 Code Committee

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Aeration Blower Fundamentals

Fundamentals of Operation and Maintenance

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Topics

- Common Types
  - Positive displacement: screw and lobe (Roots type)
  - Centrifugal: turbo, multistage, geared single stage
- Control methods for different types of blowers
- Failure modes for each type
- Monitoring and diagnostics for each type
- Typical maintenance for each type

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Disclaimer

- For all types of blowers the manufacturer's recommendations should be followed:
  - For operation
  - For maintenance
  - For repair

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Positive Displacement (PD) Blowers

- Constant volumetric flow at constant speed
- Pressure rises and falls to match system requirements

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Positive Displacement (PD) Blowers

- Two types:
  - Lobe (Roots) type
  - Screw type
- Simple operation, low maintenance
- Variable speed is only practical control method
  - Variable Frequency Drive (VFD) typical

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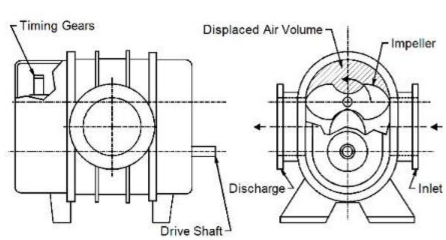
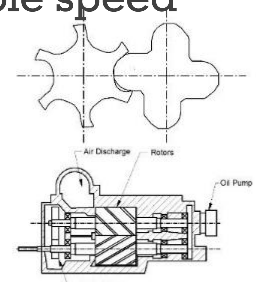
Positive Displacement (PD) Blowers

- PD must be controlled by variable speed





- Lobe Type
  - Compression external
  - Efficiency best at highest speed

- Screw Type
  - Compression combination of internal and external
  - Efficiency best at intermediate speed

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Positive Displacement (PD) Blowers

- Maintenance is similar for both types
- Lubrication is critical
  - Monitor oil levels and cleanliness
  - Change oil at recommended intervals (≈ 500-1000 hours)
  - Use right type: synthetic or petroleum, viscosity
- Belt tension and wear
- Inlet filters and pressure relief valve
- Temperature
- Noise

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Positive Displacement (PD) Blowers

- Monitoring and control is similar for both types:
- Temperature sensors: Discharge and differential
- Pressure sensors: Discharge, inlet (filter)
- Motor amperage sensors: High and low and overload
- Oil level and temperature sensor

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Centrifugal (Dynamic) Blowers

- Variable volumetric flow rate
- Pressure capability varies across a narrow range

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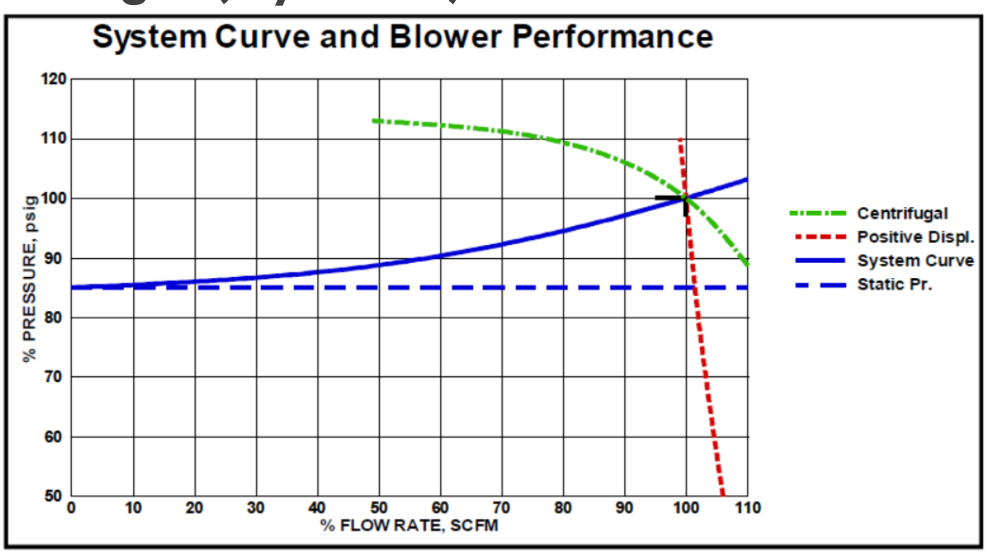
Centrifugal (Dynamic) Blowers



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Centrifugal (Dynamic) Blowers

- Three types:
  - Multistage
  - Geared single stage
  - Gearless single stage (turbo)
- Can be controlled by inlet throttling, discharge throttling, variable speed, and guide vanes
- High efficiency, low or very low maintenance

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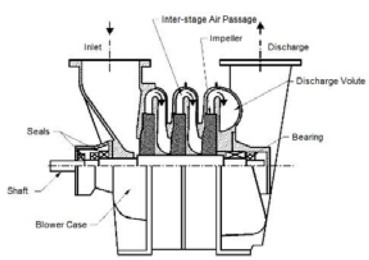
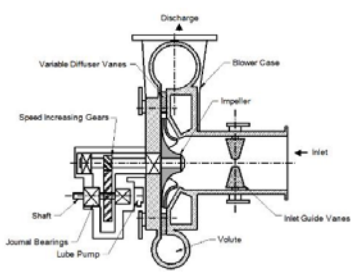
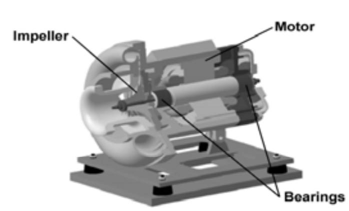
Centrifugal (Dynamic) Blowers

- Packages with all controls and accessories are available







Multistage

- Pressure achieved using several impellers in series

Geared single stage

- Pressure achieved using high-speed impeller & gears

Gearless single stage (turbo)

- Pressure achieved using high-speed impeller & motor

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Centrifugal (Dynamic) Blowers

- Most maintenance is different for each type:
- Multistage generally only require bearing lubrication
- Geared single stage requires attention to lubrication system
  - Oil quantity and quality
  - Lube system filtration
- No lubrication required with gearless single stage
- All types require attention to inlet filters

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Centrifugal (Dynamic) Blowers

- Monitoring and control for all types includes:
- Surge control/protection (surge is pulsating flow)
  - Shutdown
  - Blow-off valves
  - Modulating control
- Discharge temperature sensors
- Inlet (filter) and discharge pressure sensors
- Motor amperage sensors: High and low and overload

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Centrifugal (Dynamic) Blowers

- Capacity control varies
- All types can use variable speed (VFD)
  - This is the most efficient control method for all
  - Mandatory with gearless single stage
  - Common with multistage
  - Becoming common with geared single stage
- Multistage are often inlet throttled
- Geared single stage use inlet guide vanes or variable discharge diffuser vanes or both

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Summary

- Both PD and centrifugal blowers require some maintenance
- Both PD and centrifugal blowers can use capacity control to match system demand
- If there is a lube system, it requires the most attention
- Proper maintenance extends equipment life and reduces energy

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Paul Petersen

Municipal Sales Manager
Atlas Copco Compressors

- 9 years of experience with aeration blowers
  - Applications Engineering
  - Project Management
  - Product Management
  - Industrial & Municipal Blower Sales
- Published by TPO, Plant Services, and Blower & Vacuum Best Practices Magazines

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Total Control

Optimizing Your Process Correctly

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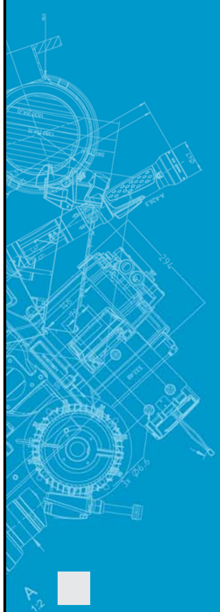

Agenda

1. Don't Reinvent the Wheel
   a. PD Blower controls
   b. Screw Blower controls
   c. Turbo Blower controls
2. Don't Partially Automate
   a. Example in CA
   b. Example in NJ
3. Keep Separate Things Separate
   a. Example in IA
   b. Example in NJ
   c. Example in MA
4. Conclusion

Atlas Copco

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Don't Reinvent The Wheel

- If equipment comes with built in control – use this to your advantage.
- If equipment comes with built in protection – use this to your advantage.
- Don't "design it yourself."
  - If you've never manufactured one, you are not the expert – the manufacturer who makes hundreds per year is.

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Don't Reinvent The Wheel

- **Don't**
  - Specify controller brands - if you are naming a reputable manufacturer, they'll support their own product better than someone else's
  - Specify individual sensor/gauge manufacturers – use the manufacturer standard
  - Specify non-standard accessories be supplied by vendor – use the manufacturer standard
  - Try to buy and maintain one-of-a-kind solutions – the manufacturer can't support what you designed yourself!
    - This always leads to buyer's remorse!
- **Do**
  - Specify the desired functionality
  - Specify the plant communication protocol:
    - Modbus/Profibus
    - Ethernet IP
    - Analog + Digital I/O
  - Specify the power supply voltage
  - Require that integrated controls be supported by a local service organization

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Don't Reinvent The Wheel

- Ex: Integrated PD Blower Controls
  - Plug & Play blower solution is easy to install
    - Single 460V electrical & discharge pipe flange
  - VSD integrated in blower cabinet
  - Local dial-a-speed doesn't require external speed signal
    - Switch for remote control allows external 4-20mA input
  - Basic alpha-numeric controller monitors discharge air pressure and temperature, provides alarm and shutdown, service notifications
  - Upgrades available for graphic controller and remote monitoring capabilities

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Don’t Reinvent The Wheel

- Ex: Integrated Screw Blower Controls
  - Plug & Play blower solution is easy to install
  - TEWC permanent magnet motor
  - Neos VSD integrated in blower cabinet
  - User-friendly Elektronikon® Touch protects the blower, gives warning indications, allows maintenance scheduling, and local pressure control
  - SCADA integration via hardwired I/O
    - Network communication optional
    - Local dial-a-speed optional
  - SMARTLINK allows online monitoring of these features plus sensor trending and energy efficiency reporting per ISO 50001

Don’t Reinvent The Wheel

- Ex: Integrated Turbo Blower Controls
  - Plug & Play blower solution is easy to install
  - Modulating BOV allows safe operation below the surge line for better process control
  - Factory-programmed control loops for header pressure control (local signal) or air flow control (external signal)
  - Continuously monitors:
    - Shaft position
    - Inlet air temperature
    - Cooling air temperature
    - Discharge air pressure & temperature
    - Motor winding temperature
    - Electrical cabinet temperature
    - Inlet filter differential pressure
    - Blower differential pressure
    - Shroud differential pressure

Don’t Reinvent The Wheel

- Ex: Central Blower Controllers
  - Offer different control modes based on user preference
    - Equalize running hours of all connected machines
    - Lead/lag sequencing
    - Optimize energy use for a given setpoint
  - Separate from process controllers for valves
  - Can be combined with DO controllers and valve controllers for lower cost than custom PLCs
  - Provide higher aeration system efficiency
  - Off-the-shelf solution can be retrofitted to existing systems and programmed to suit individual plant needs
    - Can be serviced by local technicians

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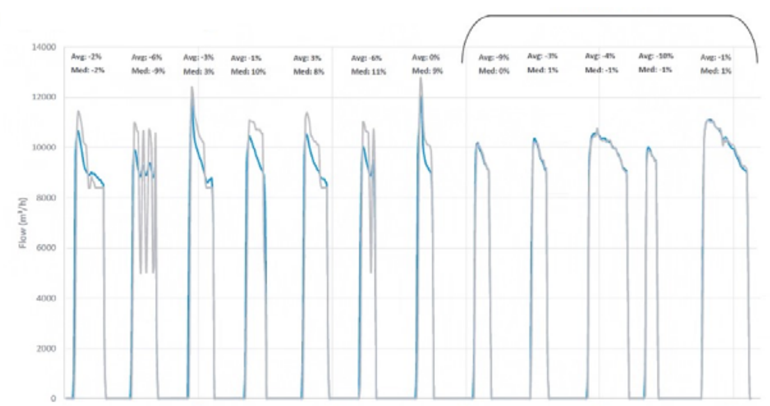
Don’t Reinvent The Wheel

- DO control of blowers on custom PLC maintained air flow within 11% of setpoint
- DO control of blowers with Optimizer blower controller installed between existing PLC and blowers maintained air flow within 1% of setpoint



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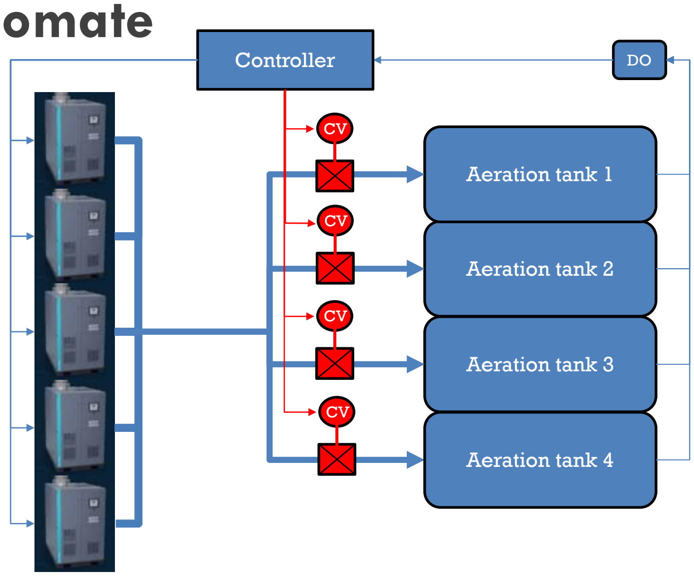
Don't Partially Automate

- Ex: In California
  - 4 basins
  - 2 DO probes per basin
  - 5 HSTB
  - 1 MCP
  - ZERO automated valves
- Don't use manual control valves with automated blowers
  - Operators can't adjust flow into each zone for accurate DO control, even if total system air flow is correct
  - Result is DO hunting = wide DO swings, lack of process control in each zone



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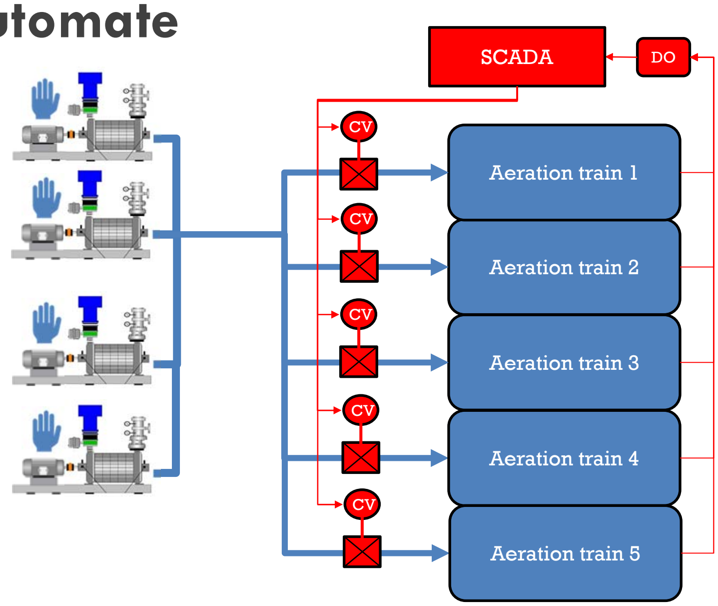
Don't Partially Automate

- Ex: In New Jersey
  - 5 aeration trains
  - 3 DO probes per train
  - 4 fixed speed MSCB
  - Air valves controlled by SCADA
- Existing automated valve system works with manual equipment
- Poor efficiency



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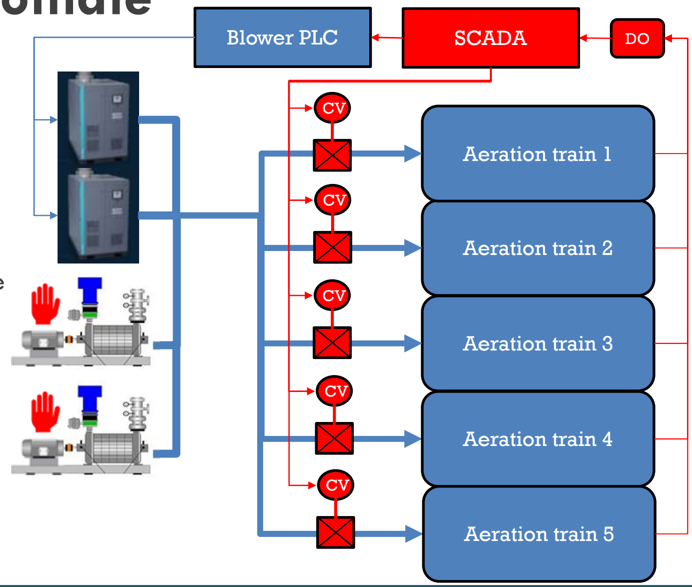
Don't Partially Automate

- Ex: In New Jersey
  - 5 aeration trains
  - 3 DO probes per train
  - 2 fixed speed MSCB
  - 2 new variable speed HSTB
  - 1 new MCP controls new blowers only
  - Old valve control system kept in place
- Half of the equipment is controlled in auto, half controlled in hand
- Old automated valve system does not work with new automated equipment
  - Creates artificial demand



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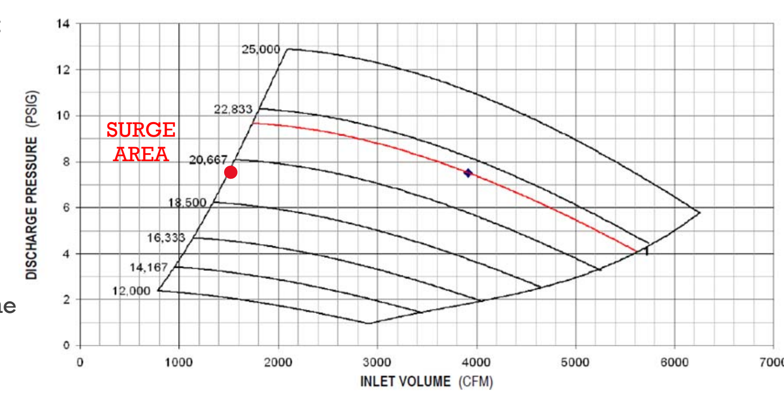
Don't Partially Automate

- When the DO probes sense too much air, the air control valves start to close
- Closing the valve increases the system pressure
- When the blower senses higher pressure, its minimum speed is increased to avoid surge
- This delivers more air to the basin
- The valve continues to close until the system pressure is greater than the blower limit, causing a fault and shutdown



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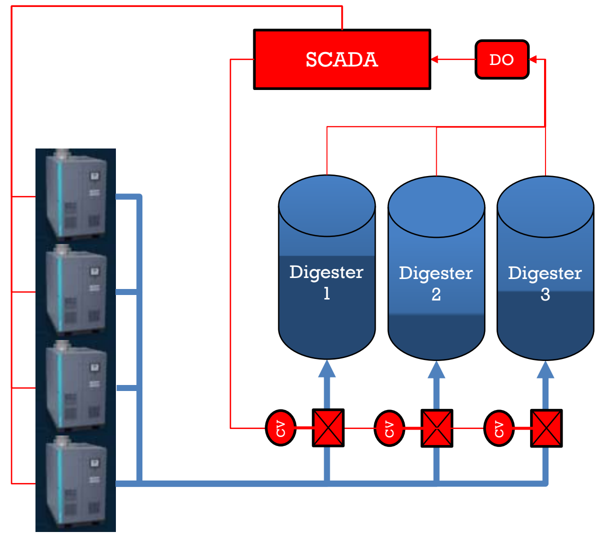
Keep Separate Things Separate

- Different processes operating at different flows or pressures should have dedicated equipment, not a centralized system
  - Centralized supply creates artificial demand
- Ex: In Iowa
  - 4 turbo blowers
  - 3 digesters – all at different SWD, out of phase
  - Deepest tank needs the most air, so valves on other tanks close to create even more resistance
    - Can't accurately control air to each digester (only "most," "some," and "least")
    - Significantly higher power costs



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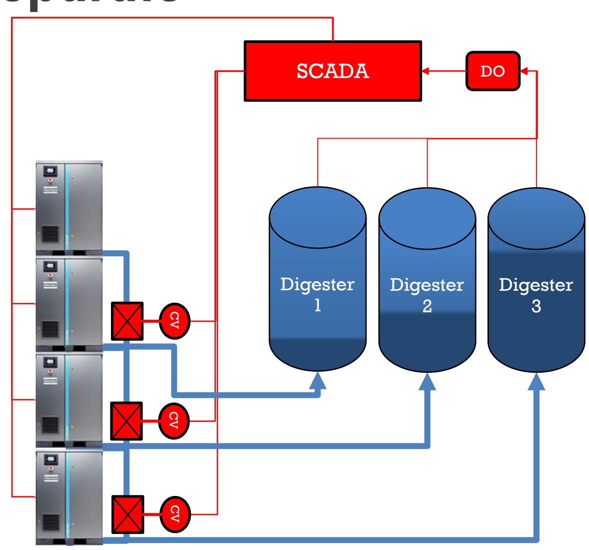
Keep Separate Things Separate

- Solution in process
  - Eliminates artificial demand
- Ex: In Iowa
  - 4 screw blowers
  - 3 digesters – all at different SWD, out of phase
  - Dedicated blower for each digester, with common spare



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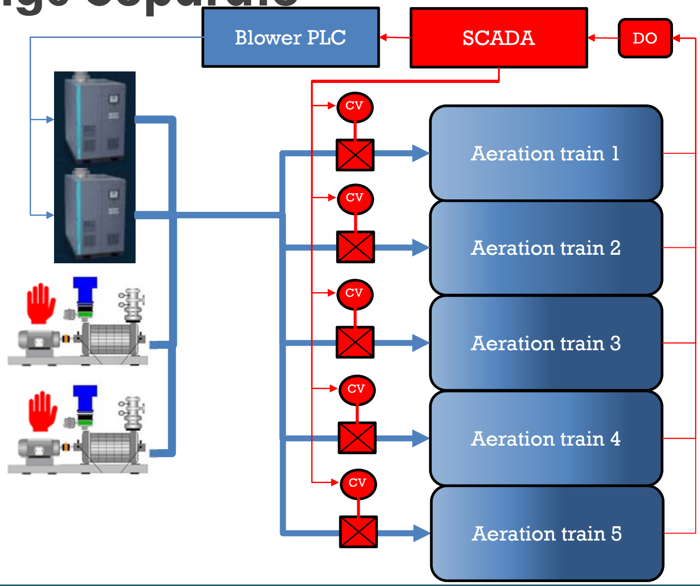
Keep Separate Things Separate

- Each process train has greatly different demand, with a common supply
  - Creates artificial demand
- Ex: In New Jersey
  - 5 aeration trains
    - Each train has different BOD
  - 3 DO probes per train
    - Only effluent probe used for blower control
  - 2 HSTB replaced 2 of 4 fixed speed MSCB
  - 1 new MCP controls new blowers only
  - Old valve control system kept in place



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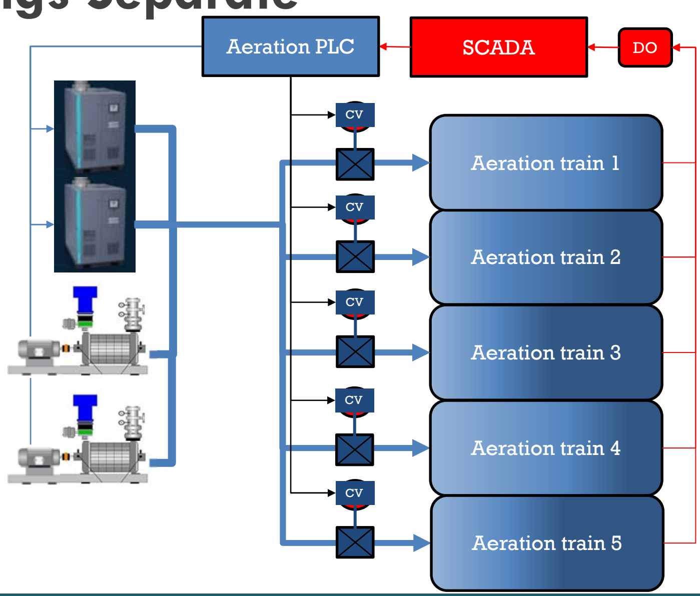
Keep Separate Things Separate

- Potential solution
  - Not yet implemented
- Ex: In New Jersey
  - 5 aeration trains
    - Each train has different BOD
  - 3 DO probes per train
    - Only effluent probe used for blower control
  - 2 variable speed HSTB
  - 2 fixed speed MSCB
  - 1 new PLC controls ALL blowers & all valves



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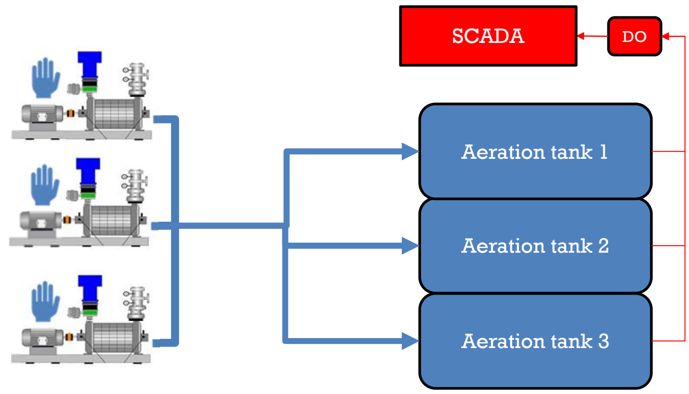
Keep Separate Things Separate

- Different processes operating at different flows or pressures should have dedicated equipment
  - Otherwise creates artificial demand
- Ex: In Massachusetts
  - DO control monitored by SCADA
  - 3 fixed speed MSCB manually controlled



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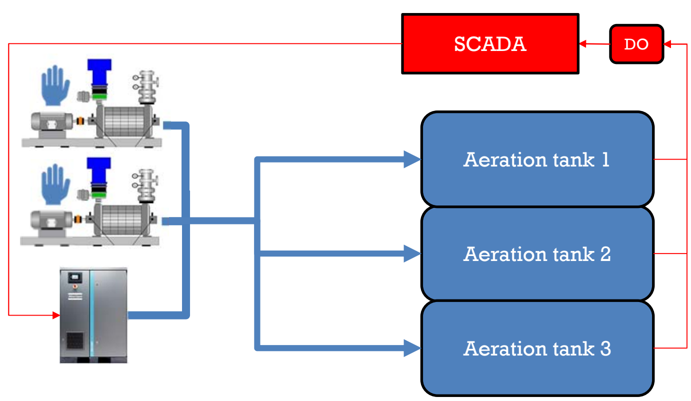
Keep Separate Things Separate

- Ex: In Massachusetts
  - 1 rotary screw VSD blower replaced 1 of 3 fixed speed MSCB
  - DO control tied into new blower only
- Instead of trying to automate all 3 blowers, only the VSD blower uses DO control
- It turns on/off automatically and increases/decreases flow automatically



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Conclusion

- To correctly optimize:
  - Utilize standard, integrated controls in new blowers & connect to plant DCS/SCADA via your preferred method.
  - Automate an entire aeration system. Partially automating will exacerbate existing problems or create new ones.
  - Use dedicated pieces of equipment for processes with different static head, flow requirements, and batch times – centralizing similar equipment on different processes makes accurate control impossible.

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Hank Andres, P.Eng.

OCWA ONTARIO CLEAN WATER AGENCY AGENCE ONTARIENNE DES EAUX | Your Total Water Solutions Provider

- Sr. Process Engineer, Ontario Clean Water Agency
- 19 years experience in the field
  - 12 years consulting engineering
  - 7 years in capital projects group at OCWA
- OCWA – 300+ WTFs, 200+ WWTFs
- Experience in both the municipal and industrial sectors
- Completed numerous capital projects to optimize process and achieve energy efficiency/savings

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Aeration System Optimization

Lessons Learned from the Field

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Outline

- Overview of OCWA Energy Conservation Initiatives
- Turbo Blower Retrofit Overview
  - 4 Installations: Belmont, St. Marys, Wasaga Beach and Kingsville (Ontario, Canada)
- Aeration System Operation – Items to Consider
- Concluding Thoughts

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OCWA Energy Conservation Initiatives

- Since March 2013, OCWA has had a contract with the Independent Electricity System Operator in Ontario, Canada
- Core Mandate:
  - To identify energy conservation measures at water and wastewater treatment facilities
  - To implement energy-efficient technology and process control strategies that will achieve energy savings

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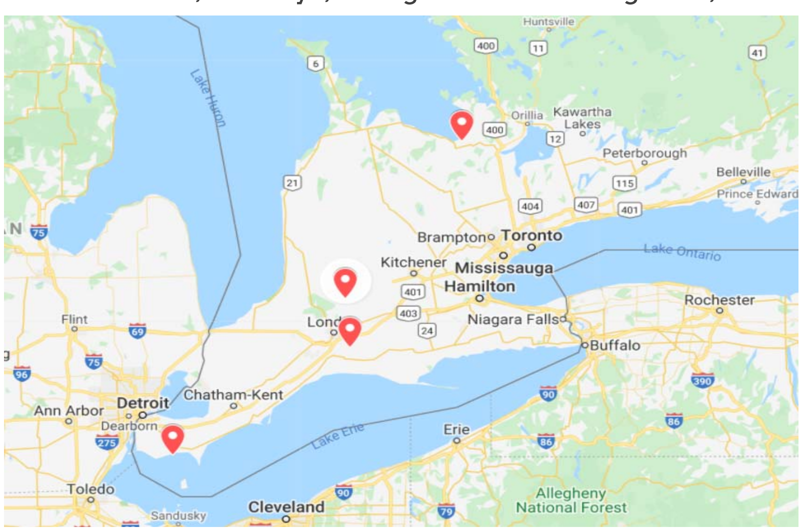
Turbo Blower Retrofit Overview

4 Installations: Belmont, St. Marys, Wasaga Beach and Kingsville, Ontario, Canada



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Overview of Existing Facilities

	Belmont WWTP	St. Marys WWTP	Wasaga Beach WWTP	Lakeshore West WWTP
Facility Type	Aerated/Facultative Lagoon	Biological Nutrient Removal	Extended Air	Conventional Activated Sludge
Design Flow (m^3/d)	1,720	5,560	15,433	5,400
Average Daily Flow (m^3/d)	670	4,270	6,780	4,860
Existing Blower Type	Positive Displacement	Centrifugal	Centrifugal	Centrifugal
Number of Blowers	4	4	4	3
Existing Blower Horsepower (hp)	2 x 75 hp 2 x 50 hp	4 x 100 hp	2 x 125 hp 2 x 75 hp	3 x 75 hp
Existing Blower Capacity (each – m^3/hr)	2,330	2,810	4,032 (125 hp), 2,016 (75 hp)	1,850
Discharge/Operating Pressure (kPa)	50 to 56	51 to 59	48 to 53	55 to 62

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Turbo Blower Energy Consumption and Associated Energy Savings

	Belmont WWTP	St. Marys WWTP	Wasaga Beach WWTP	Lakeshore West WWTP
2-Week Monitoring Period (kWh)	13,778	16,890	32,830	13,180
Monitoring Period Duration (days)	14.0	14.0	14.0	14.0
Monitoring Period Average Demand (kW)	40.9	50.3	80.9	39.2
Estimated Baseline Annual Consumption (kWh)	832,900	743,700	1,314,000	763,240
Estimated Turbo Blower Annual Consumption (kWh)	359,200	440,250	709,100	343,540
Energy Savings (kWh)	473,700	303,450	604,900	419,700
Energy Savings (%)	57%	41%	46%	55%
Energy Savings ($0.12/kWh)	$56,800	$36,400	$72,600	$50,400
Simple Payback Period w/ IESO Incentives (years)	2.6	5.2	4.1	3.7

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Aeration System Operation - Items to Consider

1. Blower Sizing and Turndown
2. Probe Location(s)
3. Dissolved Oxygen Control Strategy
4. Valves
5. Air Piping

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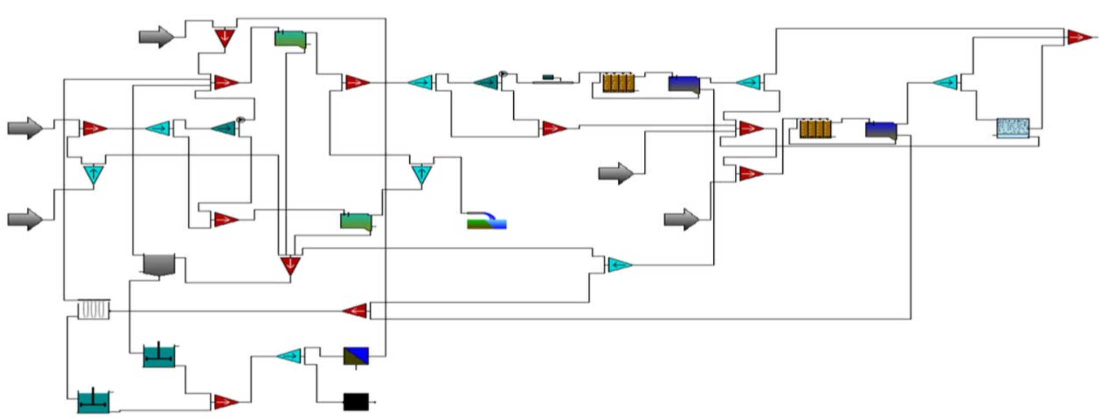
Process Analysis and Troubleshooting

A process model was useful for evaluating the impact of influent load variability on oxygen demand and plant performance:



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Process Analysis Examples

A process model was useful for evaluating the impact of influent load variability on oxygen demand and plant performance:

- St. Marys WWTP periodically experiences wastewater contributions from local food processing industries
- Wasaga Beach WWTP experiences elevated influent loading during the summer season due to an increased seasonal population
- Lakeshore West WWTP periodically wastewater contributions from local greenhouse operations and wineries

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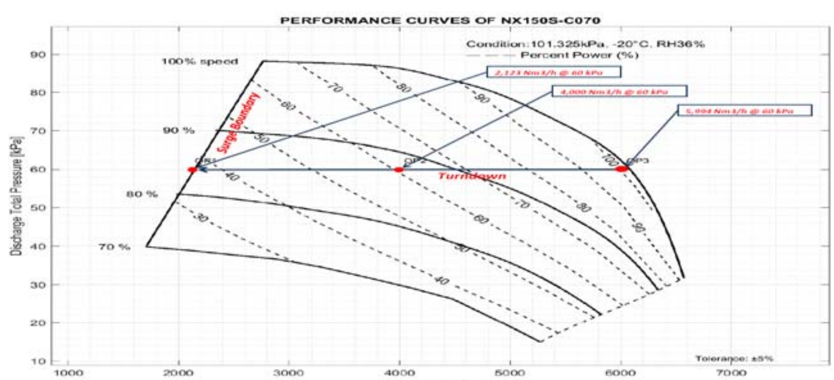
Process Analysis – Blower Sizing and Turndown

- What are the facility oxygen demands under a various loading conditions? → **what is the required blower size and turndown?**
- What are the expected blower operating points? → **now and in the future?**



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Process Control Troubleshooting

Selecting the probe location along a plug flow tank is an important consideration to achieve an adequate level of process control → **where is the ideal location?**

3-pass plug flow tank

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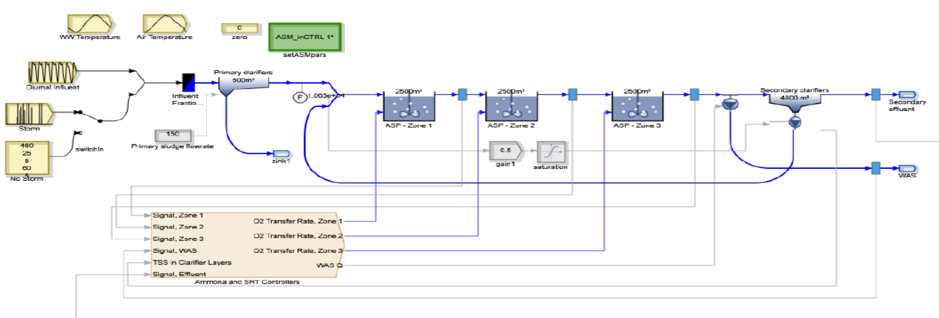
Process Control Troubleshooting

Selecting the probe location along a plug flow tank is an important consideration to achieve an adequate level of process control → **model can also be used to evaluate probe locations and fine tune process control strategies**



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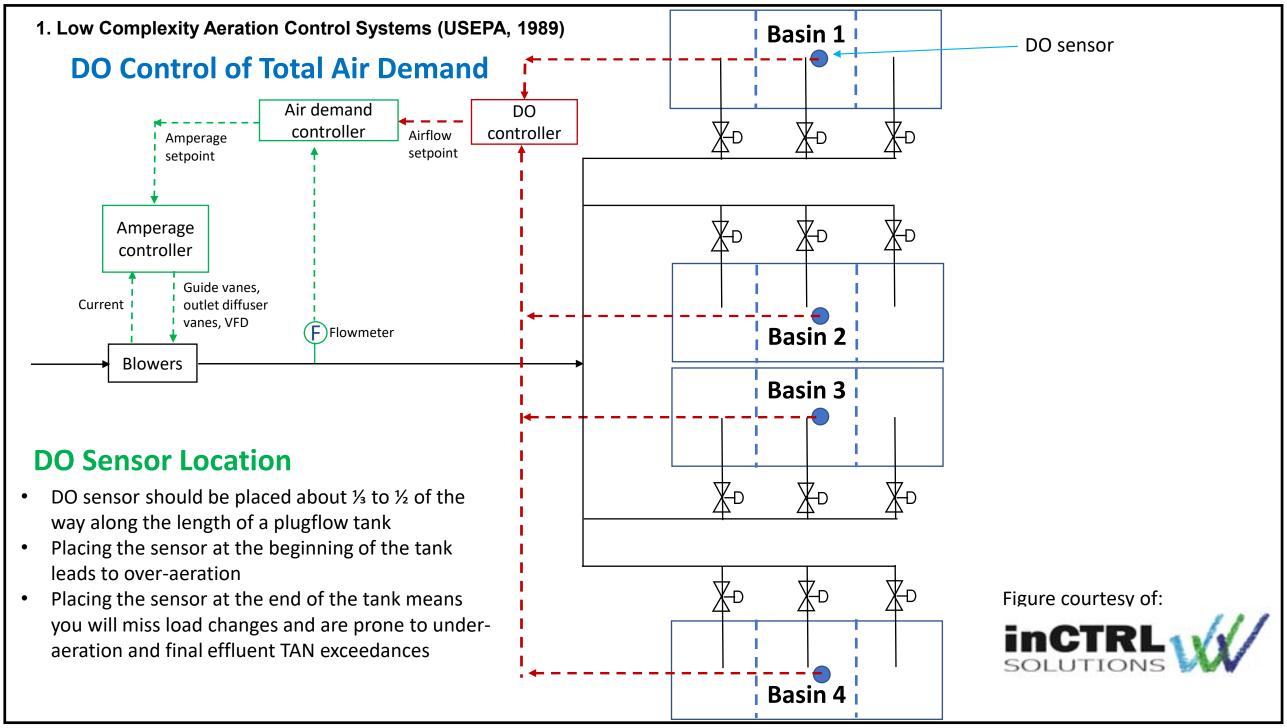
1. Low Complexity Aeration Control Systems (USEPA, 1989)
DO Control of Total Air Demand
Air demand controller
DO controller
Airflow setpoint
Amperage setpoint
Amperage controller
Current
Guide vanes, outlet diffuser vanes, VFD
Flowmeter
Blowers
Basin 1
Basin 2
Basin 3
Basin 4
DO sensor
DO Sensor Location
DO sensor should be placed about ⅓ to ½ of the way along the length of a plugflow tank
Placing the sensor at the beginning of the tank leads to over-aeration
Placing the sensor at the end of the tank means you will miss load changes and are prone to under-aeration and final effluent TAN exceedances
Figure courtesy of:

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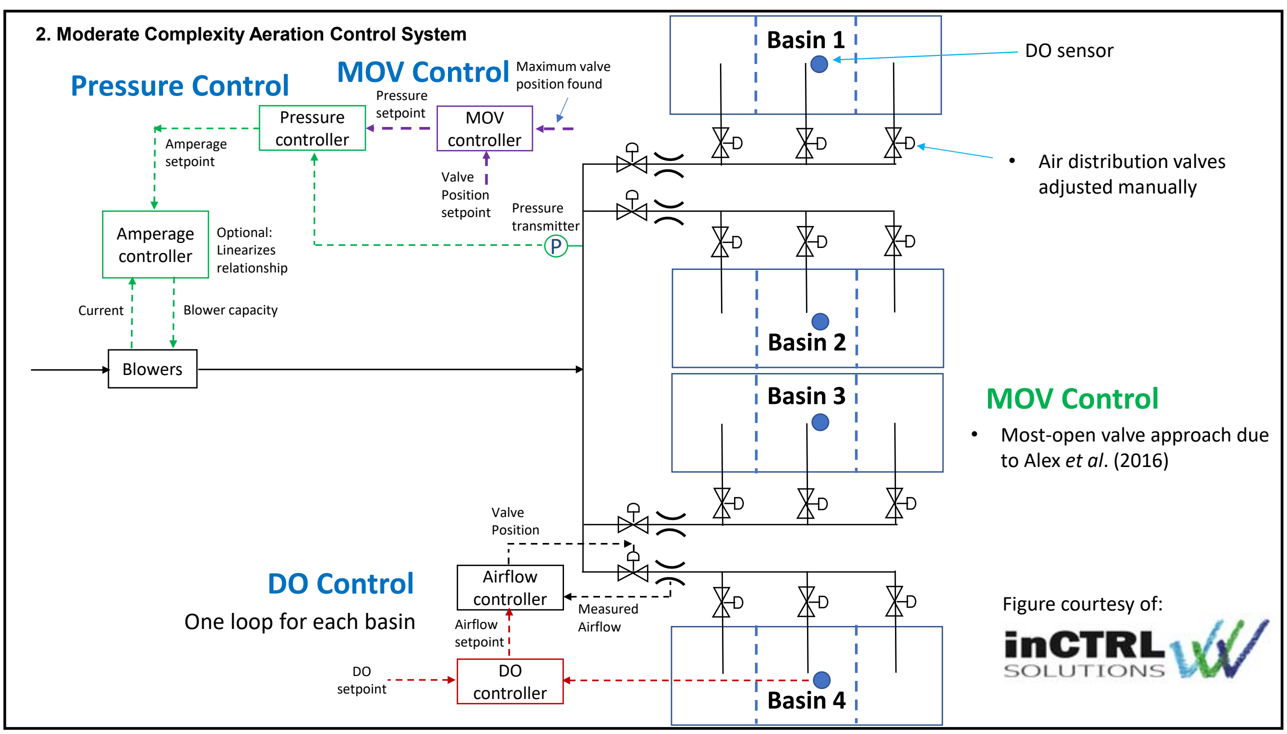
2. Moderate Complexity Aeration Control System
Pressure Control
MOV Control
Maximum valve position found
Pressure setpoint
Pressure controller
MOV controller
Amperage setpoint
Valve Position setpoint
Pressure transmitter
Amperage controller
Optional: Linearizes relationship
Current
Blower capacity
Blowers
Basin 1
Basin 2
Basin 3
Basin 4
DO sensor
Air distribution valves adjusted manually
MOV Control
Most-open valve approach due to Alex et al. (2016)
Valve Position
Airflow controller
Measured Airflow
Airflow setpoint
DO Control
One loop for each basin
DO setpoint
DO controller
Figure courtesy of:

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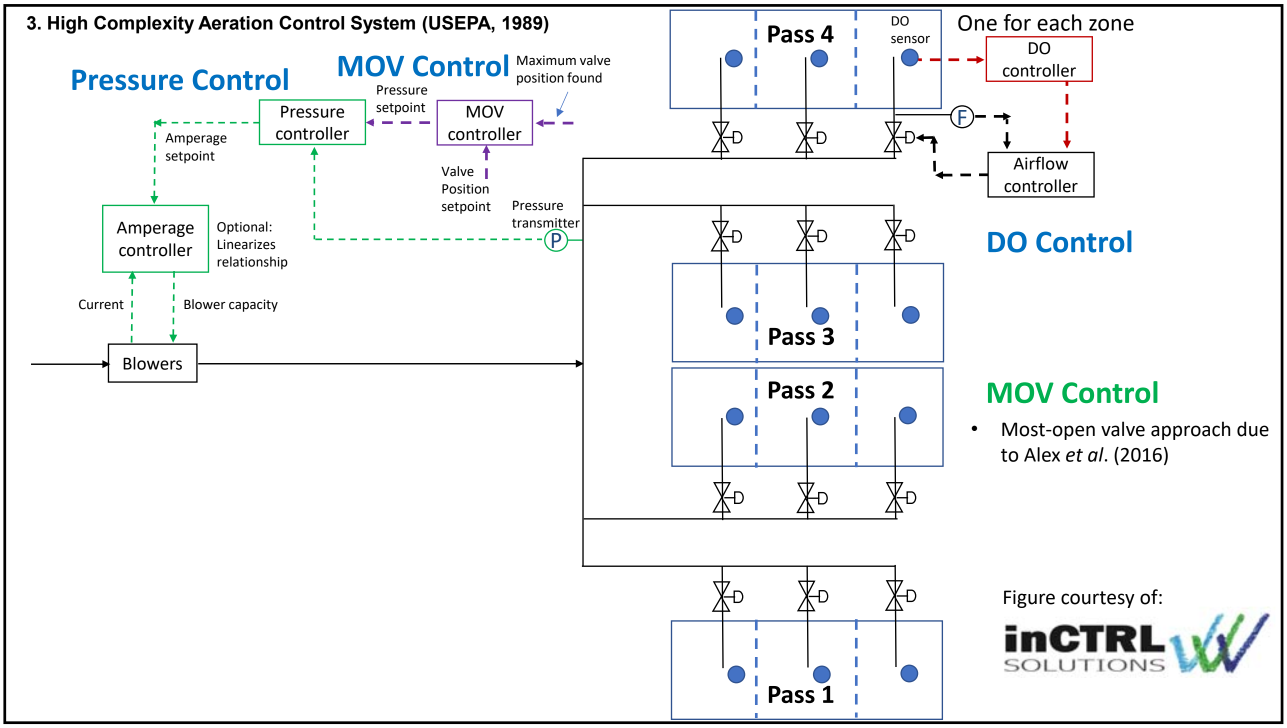

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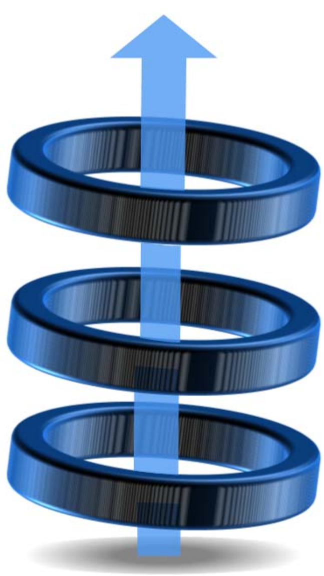
Wasaga Beach WWTF Blower Upgrade



600 MWh in annual energy savings

Better control over air flows to aeration tanks, improved floc formation and settleability in secondary clarifiers

4.1 year payback period for project based on total project cost

Existing DO monitoring system could be utilized to control turbo blower via PID controller

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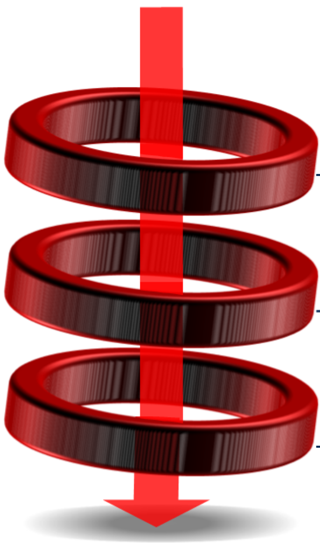
Wasaga Beach WWTF Blower Upgrade



Wasaga Beach is popular summer destination, subject to high peak loads on long weekends (Canada Day etc.)

Existing DO probes installed at the end of plug flow tank, PID controller response to peak loads was sluggish

Combination of old/broken diffusers and new fine bubble diffusers made it difficult to balance air to both tanks

Solution: DO probes moved to 1/3 length of PFT for better response, PID controller tuning was updated

Solution: Old diffusers were replaced, valves may be upgraded in future

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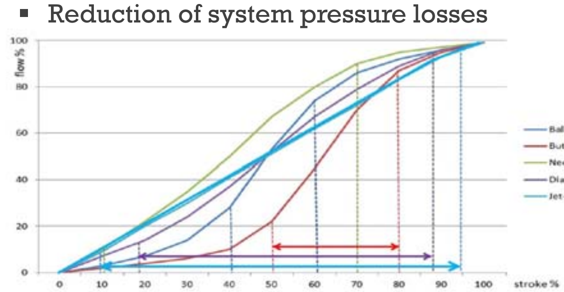
Advanced Aeration Control - Valves

- Jet/Elliptic Diaphragm Control Valves
  - Reduction of system pressure losses



  - Allows for precise control of air flow (Doody, 2017)
    - Less air is wasted, quicker response time to process
  - Has a larger stable flow/control range
  - Particularly useful for controlling the air flow split between aeration and sludge tanks when using a common blower

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Existing System Air Piping and Valve Considerations

- Non-symmetrical air piping could limit turndown range and energy savings
- Existing control valves may not provide adequate control at lower airflows
- Lower valve % Open could increase system pressure and energy consumption

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Concluding Thoughts

- Aeration Blower retrofit projects can provide enhanced process control and result in significant energy savings

- Blower sizing and turndown is important but not the only consideration
- Probes need to be in the proper location to achieve the desired level of process control
- DO control system complexity should be considered relative to the payback
  - Sometimes stable and simpler control is better
- Jet/elliptic diaphragm valves can provide more precise air control and a larger control range

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Acknowledgements

1) **A Comprehensive Aeration System Model for WRRF Design and Control**

Oliver Schraa[1*], Leiv Rieger[1], and Jens Alex[2]

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[2] ifak e.V., Magdeburg, Germany.
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2) **Design and Operation of Advanced Aeration Control Systems**

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Thank You

More Information?

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BLACK & VEATCH

Julia V. Gass

- 30 years' experience specifying blowers
- Over 60,000 hp installed
- Experience with shop testing, commissioning
- Part of ASME PTC13 Wire-to-Air Performance Test Code for Blower Systems committee

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Selecting the Right Blower Type for the Application, Maximum Efficiency, and Ease of Maintenance

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Discussion Topics

- Advantages of centrifugal vs positive displacement
- Comparative efficiencies
- Advantages/disadvantages of each blower type
- Life cycle cost evaluation
- Maintenance
- Controls
- Creative ways to justify a capital project
- Best practices

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Common Applications for Centrifugal and PD Blowers

Centrifugal

- Continuous air demand with near constant water level or water level which varies by a few feet
- Applications where capacity needs to vary without using a Variable Frequency Drive (VFD)
- Medium to large flow rate applications such as many wastewater aeration applications

PD

- Applications with significantly varying water levels such as sludge holding tanks
- Small flow rate applications
- Intermittent duty applications
- Pneumatic conveying
- Dry screw PDs are now being used for some continuous duty applications

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Comparative Efficiencies

Blower Type	Nominal Blower Efficiency, %	Nominal Turndown, % of rated flow
Positive Displacement w/VFD	60 to 45	50
Dry Screw PD w/VFD	70 to 50	40
Multi-stage Centrifugal	76 to 50	60
Single-stage Integrally Geared Centrifugal	80 to 72	45
High Speed Turbo Gearless Centrifugal	80 to 72	50

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Positive Displacement (PD) Blower Types

Blower

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Advantages & Disadvantages - PD Blowers

Advantages	Disadvantages
Low capital costs for small units	Low efficiency
Ideal for significant water level variations	Pulsations and noise
Ideal for engine drive applications and pneumatic conveying	VFD is required for capacity variation
	Timing gear contact may result in more maintenance vs centrifugal machines

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PD Blower Types

PD Lobe Blower

Dry Screw Blower

Graphics courtesy of Atlas Copco

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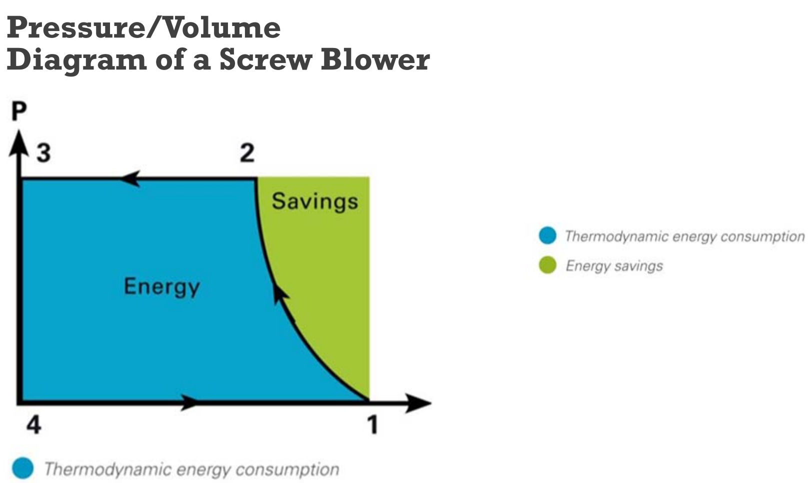
PD Blower Types



Graphics courtesy of Atlas Copco

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Advantages & Disadvantages – Dry Screw Blowers

Advantages
Idea for water level variations but efficiency not as good as standard PDs at very low water levels
Efficiency improvement vs standard PD blowers
Ideal for engine drive applications and pneumatic conveying

Disadvantages
Capital costs higher than standard PD blowers
Packaging from one vendor to another is not apples-to-apples; writing a competitive spec is difficult
VFD is required for capacity variation
Timing gear contact may result in more maintenance vs centrifugal machines

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Centrifugal Blower Types

Multistage Blowers

Lawrence, KS WWTP

Advantages & Disadvantages - Multistage Blowers

Advantages	Disadvantages
Lower capital costs compared with other centrifugal technologies	Not as efficient as other technologies used for wastewater aeration, especially when turned down
Capacity can be varied by inlet throttling without a VFD	Longer and heavier than other centrifugal technologies
No metal-to-metal contact within the machine	Not suitable for significant water level variation
Less objectionable noise than integrally geared	Less precision due to parts being cast

Centrifugal Blower Types

Integrally Geared Single Stage Blowers

Mesa, AZ NW WRF

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Advantages & Disadvantages – Integrally Geared Blowers

Advantages
High efficiency
Proven technology
Capacity control without a VFD; efficiency relatively constant throughout operating range
Precision manufacturing
Dual point control

Disadvantages
High capital costs
Pressurized oil lube system and oil cooling system require maintenance as well as vane linkages
Noisier than multistage machines
Larger footprint than gearless turbo units
Some maintenance tasks required a factory technician such as vane linkage cleaning

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Centrifugal Blower Types

Gearless Turbo Blowers

Photo courtesy of Sulzer Pumps Solutions, Inc.

Advantages & Disadvantages – Gearless Turbo Blowers

Advantages	Disadvantages
High efficiency	Higher capital costs vs multistage and PD units
Very little mechanical maintenance	Still a relatively new technology
Non-contact bearings	Electronics, non-contact bearings and permanent magnet motors required factory service
Precision manufacturing	Operating in surge for any amount of time can sometimes result in damage
Quiet operation, sound enclosure standard	
Light weight	
Shorter lead times	

Why Perform a Life Cycle Cost Evaluation

- Aeration blowers are the single largest power consumer at a WWTP typically comprising 40 to 70 % of plant power consumption
- More efficient technologies are typically higher in capital costs
- Revolution in blower technologies over the last 10 years

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How to Perform a Life Cycle Cost Evaluation

Table 1 – Operating Conditions and Weighting Factors

Operating Points	Conditions	Air Flows	Weighting Factors
1	Maximum month air flow, summer ambient conditions	14,600 scfm	10%
2	Annual average air flow, average ambient conditions	13,500 scfm	80%
3	Minimum air flow, winter ambient conditions	1,500 scfm	10%

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How to Perform a Life Cycle Cost Evaluation

Table 2 – Capital Costs	
Blower alternative	Capital cost
Alt 1: Integrally geared (3 large duty, 1 large standby, 1 small duty)	$2,172,625
Alt 2: Gearless turbo (3 large duty, 1 large standby, 1 small duty)	$1,750,000

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How to Perform a Life Cycle Cost Evaluation

Table 3 – Operating Costs (Power)		
Alt 1: Integrally Geared	KW	$
Operating point 1	804.8	
Operating point 2	691.5	
Operating point 3	88.7	
Total	5628.7	562,9000
Alt 2: Gearless Turbo		
Operating point 1	203.0	
Operating point 2	609.0	
Operating point 3	83.0	
Total	5008.1	500,809

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How to Perform a Life Cycle Cost Evaluation

Table 4 – Summary of Present Worth Evaluation (20 Year Period)				
	Alternative 1		Alternative 2	
	Integrally Geared Blowers		Gearless Turbo Blowers	
Present worth capital costs, $	$2,173,000	24% Higher	$1,750,000	Lowest
Annual operating power costs, $	$563,000	12% Higher	$501,000	Lowest
Present worth power costs, $	$7,650,000	12% Higher	$6,806,000	Lowest
Total present worth, $	$9,823,000	15% Higher	$8,556,000	Lowest

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Maintenance Tasks

Single Stage Integrally Geared Centrifugal	Single Stage Gearless Turbo Centrifugal	Multistage Centrifugal	Rotary, Positive Displacement
Inlet filter element	Inlet filter element	Inlet filter element	Inlet filter element
Lubricant addition and changeout	Non-contact bearing replacement	Lubricant addition and changeout	Lubricant addition and changeout
Lubricant filter	Permanent magnet motor replacement	Antifriction bearing replacement	Antifriction bearing replacement
Vane linkage	Electrical/harmonics issues	Seal replacement	Lobe clearance adjustments
Oil cooler cleaning			Seal replacement

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How Maintenance Considerations Impact Blower Type Selected

- Gearless turbo blowers have almost no mechanical maintenance. Electronics maintenance needs to be performed by factory technicians.
- Some plants prefer to do their own oil changes, alignment, etc.
- If the plant prefers a factory technician or maintenance contract, gearless turbo blowers may be the answer. If the plant prefers to do their own mechanical maintenance, a more traditional technology may be a better fit.
- Combination of traditional maintenance by plant staff and a maintenance contract may be the best choice.

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A Word about Controls

- A dissolved oxygen control system with most-open valve control also saves power consumption.
- An integrator experienced with WW aeration controls is key to making this work.
- Single source responsibility for blowers and basin control helps this go most smoothly. The blower mfr or their integrator is often the best entity to perform this work.

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Creative Ways to Justify or Finance a Capital Blower Project

- Consider replacing only some units
- Consider electric utility rebates
- Consider ESCO projects

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Best Practices

- Lowest life cycle cost blower technology
- Efficient control system which functions without "hunting"
- Bid for efficiency – specify guaranteed power numbers or require an evaluated bid
- Verify performance by shop testing

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Summary

- Advantages of centrifugal vs positive displacement
- Comparative efficiencies
- Advantages/disadvantages of each blower type
- Life cycle cost evaluation
- Maintenance
- Controls
- Creative ways to justify a capital project
- Best practices

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Questions & Answers

Thank you for joining us today!

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